TOPSIS
for CAPEC Supply Chain Vulnerabilites

SRM_2022 / L. M. Saxton

TOPSIS

- TOSIS stands for “Technique for Order of Preference by Similarity to Ideal Solution” (Soczewica, 2020)
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- TOPSIS works best with linear data – i.e. a linear graph equation (Çelikbilek & Tüysüz, 2020)

- TOPSIS comprises 3 equations with a total of 6 steps:
  - https://www.youtube.com/watch?v=Br1NQK0Iumg

TOPSIS

- Goals for this calculation:

  1. To rank the severity of each Supply Chain attack on a scale between 0 and 1

  - Technically this is not how TOPSIS is usually used
  - We are inverting the use of 1 and 0 – normally 1 is the best and 0 is the worst (called ideal best and ideal worst values)
  - We are using 1 as the most dangerous attack combination and 0 as the least dangerous, based on the CAPEC rankings of Attack Likelihood, Typical Severity, and Skills Required.

TOPSIS

- Goals for this calculation:

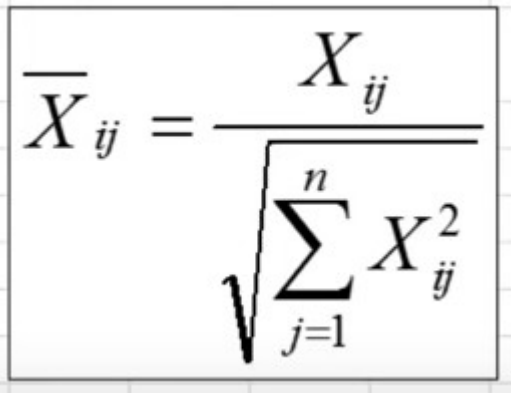
  2. To use the rankings of each Supply Chain vulnerability to determine the probability of each attack combination present in the data

  - This requires the standard probability equation of $a/(a+b+c...n)$
  - Counts the instances of each possible Attack Sev / Typical Sev / Skills Req combo present in the data

- Let’s take a look at the data before TOPSIS:

TOPSIS

- Equation 1:



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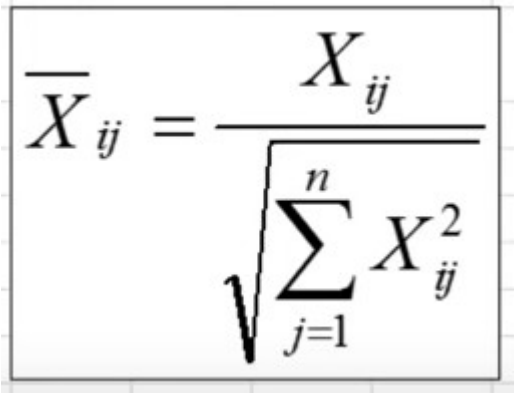
- Equation 1:



1. Calculate the Normalized Matrix

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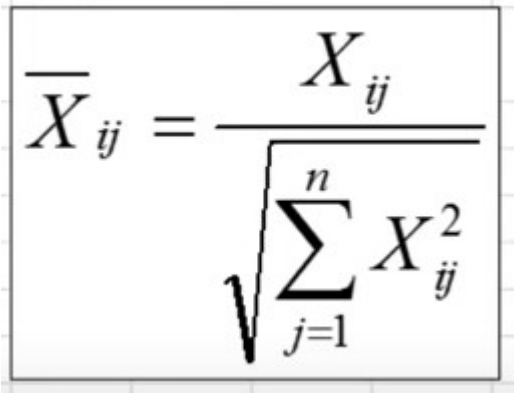
- Equation 1:



1. Calculate the Normalized Matrix
   - How can we do this on Excel?

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- Equation 2:

$$V_{ij} = \bar{X}_{ij} \times W_j$$

TOPSIS

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$$V_{ij} = \bar{X}_{ij} \times W_j$$

2. Calculate the weighted Normalized Matrix

- Weights were equated equally by 1/3 for the initial equation
  - Can be changed if more appropriate.

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3. Calculate the ideal best value

- V+

4. Calculate the ideal worst value

- V-

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- Equation 3:

$$S_i^+ = \left[\sum_{j=1}^{m} \left(V_{ij} - V_j^+ \right)^2 \right]^{0.5}$$

$$S_i^- = \left[\sum_{j=1}^{m} \left(V_{ij} - V_j^- \right)^2 \right]^{0.5}$$

TOPSIS

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5. Calculate the Euclidean distance from the ideal best (Si+) and worst (Si-) values

TOPSIS

6. Caluculate the performance score (Pi)

- This score will provide 2 things:
  - A calculation of distance between the worst possible attack (1) and the least possible attack (0)
  - The ability to rate the probability of occurance of each type of attack combination
- Let’s look at the data: